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CANCER RESEARCH AND THE SCIENTIFIC METHOD[1]

By Dr. ELLICE McDONALD

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CANCER is the most important problem of our time, for two reasons: first, because it kills people more than any other single disease (heart disease, which is higher in the mortality records, is a combination of heart and kidney and other diseases); second, because it has increased so greatly in incidence in recent times —62 per cent. more deaths in Pennsylvania in twenty-five years, 40.5 per cent. in Australia in ten years, 58.2 per cent. increase in 50 American cities with more than thirty million total population in twenty-five years, and in somewhat lesser degree in all civilized communities. In Great Britain in 1928, more than 12 per cent. of all deaths were from cancer, and a great insurance company has estimated the yearly loss from cancer in the United States to be about eight hundred million dollars.

Obviously the disease is a subject to warrant careful consideration and organized effort, for it touches the life of a great number of people. What has been done about it? A devoted group of medical men in a number of countries have studied the disease in man and in animals for many years, with the result that the treatment of cancer has improved in two directions—improved surgical treatment and treatment by radiation, x-rays and radium.

In medicine, as in all other forms of human endeavor, real ideas are rare; methodical development of ideas, after these are suggested or discovered, is common. The development of the automobile, for example, was only an elaboration of detail after the

[1] Address before the American Pharmaceutical Association, Philadelphia, April 14, 1931.

idea of the internal combustion engine was discovered. All else that followed, to our smooth-running motor cars, was elaboration and development of a central idea. In surgery, for these fifty years, the Pasteur idea of defense against the invading parasite has been the central purpose, and all surgery has been the elaboration of the idea of infection by micro-organisms of that French chemist, and this elaboration has been carried to a degree of detailed sophistication. Cancer has had its share in gaining better surgical methods, improved technique and earlier diagnosis, to gain better results than the old results which were nil. But surgery is only applicable to such cancerous growths which are easy of access, which do not involve a vital organ or have not produced additional subgrowths called metastases. In other words, if the cancer can be completely cut out, surgery is of use; if it can not, surgery had better not be attempted. Yet in the best clinics and under the best auspices, 75 per cent. of cancers are not suitable for surgical treatment because extension of the disease has already occurred.

Another accident led to the knowledge of the value of radium, when Becquerel carried a small amount of that strange substance in his coat pocket and found that after some time a destruction of the tissue of his skin, amounting to an ulcerating sore, occurred. This led to the idea that radiation from radium and, by analogy, radiation from x-rays, might be of use in the treatment of cancer. Since 1910, we have been concerned with elaboration of detail in the use of radiation, with improving methods of application and perfecting apparatus. So that now with surgery, aided by radiation under the very best auspices, about one third of all cancer cases, as they come, can be cured. In this country, under the disorganized methods, it is very difficult to estimate the total number of cures of cancer; but, after several years of collection of opinions and statistics, the total percentage of cures in cancer is estimated at less than 10 per cent. and more than five per cent. of all cases treated.

In fifty years of antiseptic surgery following the beginning of the Pasteur idea, and in the twenty years following the idea of Becquerel and Curie, we have been able to develop only two methods of treatment for cancer, neither of which gives anything like satisfactory results, but we use them because they are the only ones available. Both of these methods resulted more from happy accident than from any really intelligent investigation of the problem. They were not even the result of trial-and-error method of research, but they happened because one was interested in the care of vineyards and because another received a burn from a rare and new substance. Yet these two methods, surgery and radiation, are at the present time the only available and responsive measures for the treatment of cancer, and, with them, the very best we can hope is to cure one third of all cancer cases, obviously a confession of failure.

In these fifty years, research in cancer has not been without earnest activity, yet the pertinent facts collected have been few. Many men have devoted their lives to this or that phase of cancer research and yet the total sum of knowledge has not been noticeably advanced. It reminds me of my daughter, who has recently become engaged to be married and brought home four great books. Being always interested in books, I asked, "What have you there?" She said: "Before beginning any problem, you told me to collect all the available data, and these are cook books." Maybe cooking is the most important phase of the marital state and yet possibly other uncorrelated human activities, in a lifetime of mutual association, may also enter. In research into cancer (and it has been almost entirely by medical men), there has been a similar lack of correlation and lack of coordination. No definite consideration of the problem has been taken any more than in any other medical problem, except that "here was a disease and how can we cure it." Such research as has been done in cancer has followed the trial-and-error type of research, as is familiar to the medical investigator under the term the empirical method.

Yet why should it be so? Life is a very definite reaction which occurs and recurs according to definite constancy, and cancer is only a problem in the reproduction of a life history of cells, for cancer is a problem in cell division. A disease, such as cancer, is not a thing but a state, a deviation from normality. The cells, after our youthful growing period, have ceased to grow with arrival at adult age, or certain inhibitions to growth have occurred. In cancer, which is generally a disease of the latter half of life, certain cells have lost their inhibitions to growth and renew their power of division into a multiplicity of cells, almost always beginning in a local area. These cells are carried to distant parts of the body and maintain there the characteristics of the original cells, including their power of division and multiplication. Death occurs from extension of these cells as a growth to some vital organ impairing its functions, to a general extension of the growth producing such poisons as to alter the functions of the blood and other parts of the human organism, or by creating such obstruction, or lowered resistance, so that a terminal and fatal bacterial infection results.

The disease is a cellular disease so that the cell, the smallest particle capable of sustaining life, is our unit, as the atom is the unit of the physicist and the molecule of the chemist. All life forms are colloid in

character and we have to do with a heterogenous system, elaborated into a polyphasic organization and with definite structural arrangement. The chemical complexity of the cell would be baffling were it not that there are phenomena which are common to all cells. Nature at some stage in her complexity rejuvenates her simplicity. The atom, the unit of the physicist, by structural associations, forms the molecule which is equally satisfying to the chemist. The molecules form the cell where there is again renewal of the simplicity.

The cell, in the study of cancer, is the unit and has a definite arrangement or organization. It is possible to create a model for thought exactly as the physicists create a model of the atom. In fact, cancer research is going through the same stages of development as has physics. Twenty years ago, physics seemed at the end of its great discoveries and all else seemed to be elaboration of detail. There was an atom, the smallest unit; which was described in terms of (1) words. Along came Nels Bohr and Lewis with the construct or (2) a fixed model of the atom. This was developed into Bohr's atom with its moving orbits and relation to Planck's constants, (3) a model in terms of operation. This was again extended to the Schroedinger wave dynamics which only can be described in the language of (4) mathematics.

In cancer, and indeed in all biological and medical research, we are just emerging from the (1) word stage. But it is possible to begin the advance to the second stage of construct or (2) the fixed model. Lord Kelvin said: "I never satisfy myself until I can make a mechanical model of a thing. If I can make a mechanical model of a thing, I can understand it. As long as I can not make a mechanical model all the way through, I can not understand it."

In cancer research, it is possible to take as a construct, or a fixed model for thought, the cell with the component parts of its system. The cell consists of (1) the nucleus, (normally with a pH of about 7.5), (2) the protoplasm (normally with a pH of about 6.6), (3) the cell membrane, and (4) the environment, which is the blood (with a normal pH of 7.38 and more alkaline in cancer) and tissue juices. The environment must be considered, for the cell and its environment are one. All energy forms, and the cell is an energy adapter, are brought to the cell and so enter the cell through the environmental phase. In consideration of alteration in cellular reactions, the environmental phase is of the greatest importance because alterations in this phase determine the reactions of the cell, and through this phase must go any influence, excepting radiation, which will prevent the cell division or cure cancer. Part of the mistakes in the study of cancer in the past have been the consideration of the cell alone as studied through the microscope in dead and stained preparations. In this, the most important phase in determining cell activity, the environment, was not considered.

Our unit system may therefore be thought to consist of four distinct portions: (1) nucleus, (2) protoplasm, (3) semi-permeable cell membrane, and (4) the environment from which the cell receives its energy-producing materials and through which the products of reaction are removed. The protoplasm is an intimate association of salts, carbohydrates, fats and proteins, many of which are specific to a high degree and which are partly contained in true solution and partly in a poly-dispersoid state.

In the continual exchange of materials and energy, the processes of oxidation-reduction are of outstanding importance. If we deny a cell oxygen, it either gradually ceases to function and dies or, like yeast, it adapts some form of anaerobic break-down in place of oxidation; if anaerobic break-down fails, the cell then perishes.

Life is an oxidation-reduction rhythm dependent upon oxidation-reduction potential which decides which one of two systems will oxidize the other. Since the process involves a transfer of electrons from oxidant to reductant, we may, by an adaptation of the Nernst formula, arrive at the following equation:

$$E_h = E_o - \frac{RT}{nF} \ln \frac{(Red)}{(Ox)}$$

where E_o is the voltage with respect to the hydrogen electrode as O; E_o is the normal electrode potential; *Red* and *Ox* the concentrations of the reductant and oxidant, respectively, T the absolute temperature, and R the gas constant. It is important to recognize that this treatment applies to only perfectly reversible processes and herein lies the difficulty of applying it to vital systems whose processes are not generally reversible. However, many biological oxidations which are apparently irreversible proceed by a number of stages, some of which are truly reversible.

The oxidation-reduction potential decides in which direction the reversible reaction will proceed, but the rate is determined mainly by the oxidative catalysts whose influence must therefore be a most essential factor in the problem. In these cell oxidation-reduction processes, there are living catalysts which are known as "the dehydrogenases or dehydrases." Their function is to activate molecules so that they act either as hydrogen donators or hydrogen acceptors, depending upon the nature of the molecule and the conditions of reaction. The so-called inorganic ferments, or heavy metal catalysts, also play a great rôle in

vital oxidation-reduction processes. In the living cell, other chemical substances form reversible oxidation reduction systems, the most important of these being the sulfur compounds of the type RSH–R-S-S-R, the former being the reduced form. In this class are the cystine-cysteine and the glutathione-reduced glutathione systems and, in addition as oxidation-reducing systems the fatty acids and carbo-hydrates.

There is no doubt, in life processes, that a steady dynamic state exists which is not chemical equilibrium, but which may be conveniently spoken of as biological equilibrium, and through which energy may be liberated.

The normal processes of the living cell are brought about by a continuous energy interchange which is dependent upon the physical, chemical and colloidal state of the cell constituents and which, in its explanation, must be correlated to the fixed model of the cell with its four component systems of (1) nucleus, surrounded by (2) protoplasm, enclosed by (3) cell membrane, and existing in (4) environment.

These processes are dependent upon two great factors: (1) conditions of biological equilibrium or balance, and (2) catalysts of the oxidation-reduction type. Their alteration in activity is influenced by conditions of biological equilibrium. For example, F. G. Hopkins has shown that glutathione (GSH) promotes the oxidation of certain unsaturated fatty acids, the O being transferred to the unsaturated linkage of the fatty acid, while the original SH groups are reconstituted. At pH 7.4–7.6 the system, GSH + unsaturated fatty acid, behaves differently; here the O uptake is equal to the amount required to oxidize the SH. The SH group is no longer an oxygen carrier but becomes represented by $AO_2 + B \rightarrow AO + BO$ where A is an auto-oxidator and B an acceptor. On the acid side of pH 7.4 the protein SH is oxidized and the total O amounts to ten times the O equivalent of the SH; at pH 7.4–7.6 the O uptake amounts to only sufficient to oxidize the SH. This is significant of the influence of conditions of biological equilibrium on the effect of catalysts (or as the biologists call them: enzymes). It is also significant that, in cancer, the blood, or (4) environment of our fixed model, has been found, by us, to be considerably more alkaline or averaging pH 7.44, where normal blood plasma is pH 7.38.

The oxidation-reduction equilibrium (rH) which is the analogy to the intensity of acidity or pH, is of enormous importance to these vital oxidation-reduction systems. The rH is a negative logarithm of the hydrogen pressure in equilibrium with the oxidation-reduction system in question. In simple systems, rH is a function of pH and Needham and Needham have shown that it holds similarly for living cells, that rH is a function of pH. Our only and main interest in pH is that it gives some measure of rH and is an easy and exact measurement capable of statistical estimation. The ideal is rH measurement; the means are pH measurement.

There is, therefore, to be considered (always remembering our fixed model with its four component system) a scheme as follows:

VITAL CELL SYSTEM INFLUENCES

Catalysts (enzymes, etc.)	Condition of biological equilibrium
Glycolytic enzyme	pH
Co-enzyme	rH
Fe in the hemin form	Ionic concentration of inorganic substances
Glutathione-reduced glutathione	Glucose concentration
Cystine-cysteine	Aggregation and dispersion of the colloid
Dehydrogenases including (1) heat labile catalysts acting on the substrate (2) intermediate reversible H and O acceptors and (3) heat labile oxidants sensitive to CN	*Buffer systems* Phosphates Carbonates Proteins oxy Fe–red Fe RSH–R-S-S-R

In such a scheme as this, it must be decided where these reactions take place, in what part of our four component system? This is the mechanism of energy adaptation in the cell and, in cell division, there is an enormous increase in energy turnover, over one thousand per cent. increase in certain cells, as has been shown by Joseph Needham, after fertilization of the *Ameba Proteus*.

Mechanism, in cancer research, is much more important than cause or end results, which have heretofore been the main efforts. Cancer may be produced by tar and other means which points to the fact that the cause of cancer is a state of the cells, favorable for division and produced by more than one stimulator. The end result is the tumor or the fixed dead stained preparation under the microscope. To attempt to reconstruct the mechanism of cancer from the microscope preparation is as hopeless as to reconstruct a bolt of lightning from the devastation it produces.

Glycogen is the sole source (or almost) of cell energy. Warburg and his coworkers have shown that in cancer the glycolytic activity of tumor tissue is greatly increased. For every thirteen sugar molecules attacked, twelve are split up into lactic acid and one oxidized, while in normal tissue this ratio

is approximately 1:1. Mellanby and Harrison have shown that cancer tissue does not form lactic acid from the Robison ester, while normal tissue does. These findings make it necessary to postulate a different *mechanism* for the formation of lactic acid by cancer tissue or, in other words, there is deviation of the reaction in cancer cells from normal cells. As an energy adapter, the cancer cell follows a different mechanism from normal. This is one of the most significant facts of present-day cancer research. If it were possible by alteration in the cell influences, as shown in the table, toward restoration of normal metabolism (or reactions) cancer would be cured, because the only perceptible difference between a cancer cell and a normal cell is a difference in metabolism. The nature of the injury to the oxidative processes in the cell is the fundamental metabolic problem in cancer and the cure of cancer will come through the production of a more oxidizing potential than the limiting oxidation-reduction potential necessary to cell proliferation.

In our laboratories, we have shown that, in general cancer blood plasma (or (4) environment) there is a relative alkalinity amounting, in untreated internal cancers, to a change from normal pH 7.38 to pH 7.47, or approximately 18.7 per cent., more alkaline. These changes of pH may seem small to the chemist but they are enormous to the biologist. In cancer, therefore, there are alterations in conditions of biological equilibrium (see table) of pH which involves alteration also in rH and alteration in the action of the catalysts as each, no doubt, has an optimum pH at which it is effective and with alterations in pH, the catalyst either is not effective, or new catalysts come into play. In other words, alteration in conditions of biologic equilibrium may produce alterations in mechanism of reaction.

Our observation that, in untreated cancer, the duration of life is a function of pH and the more alkaline the blood plasma pH of the untreated patient, the quicker the disease kills, is significant of the influence of conditions of biological equilibrium upon the growth of the tumor and course of the disease.

Another interesting finding, which apparently has considerable evidence, is that cancer patients have relatively more sugar in their blood than normal and that, generally speaking, the more sugar in their blood, the worse is their expectation of life. This is borne out by our preliminary investigations, although the problem is still being studied.

In addition to these facts, it has been pointed out by Clowes, Rohdenberg and others, that cancer cells have relatively less calcium than normal and relatively more potassium and that, with increase of potassium content, there is an increase of the virulence of the tumor, or the virulence of the tumor is (in part, at least) a function of the potassium content. In our own laboratories, we have often found that, in spontaneous mouse tumors, calcium salts have an inhibiting influence on the growth of the tumor.

With these few facts, we can begin to state the direction in which research must tend. In order to have a cure of cancer, conditions must be produced which will: (1) alter glycogenolysis toward normal from the cancer type, (2) produce conditions of biological equilibrium towards normal from the alkaline state (pH 7.47 in internal untreated cancer blood plasma), (3) reduce the high blood glucose, (4) produce a calcium-like effect, (5) reduce or prevent the potassium-like effect.

These criteria are few, but at present these are the sole criteria for a cancer cure and the future will lay down more and more specifications until these become so obvious to some genius, who will say that with those specifications the answer can only be one thing to satisfy all the requirements.

In any consideration of these criteria, due consideration must be given to the conditions of mechanism as shown in the table, because mechanism is more important than results of reaction. If we know the mechanism, it may be possible to throw a monkey wrench into the wheels, and alter that deviation from normal reaction which is characteristic of cancer cells.

Trial-and-error methods of experimenting with one thing after another, characteristic of past cancer research, is a hopeless job. Human experimentation is limited because it takes at least six years for one experiment and, during that time, one can not deny to the patients the beneficial effects of radiation treatment, which masks the result of the experimental treatment. Animals with their shorter lives are available for treatment with chemical substances, but it takes at least six months to put one substance to trial, and, in the three years, we have been continuing some animal experimentation in our laboratories and testing a comparatively few substances, at least 100,000 new substances have been produced by the organic chemists. So the trial-and-error type of experimentation offers little hope, only a gambler's chance—a 20,000 to one shot. The past experiment offers no indication as to what the next should be.

The attempt, however, to estimate the available data and to lay down specifications for the alterations required in producing a deviation from the cancer metabolism towards a normal mechanism, offers hope of the application of the scientific method to cancer research, so that each set of experiments will produce data to extend knowledge and lay the basis for future experimentation.

Cancer research in our laboratories is the study of oxidation-reduction rhythm in vital systems as influenced by conditions of biological equilibrium and affected by catalysts, always considering the four component system of the cell and its environment. The foregoing may seem a simple sentence but it has taken me thirty years of my life to get there.

Continuation of experimentation along lines of the scientific method, in distinction to the trial-and-error method, can not but end in that consummation, devoutly to be wished for, a chemical cure for cancer, which, in my opinion, is only a matter of time and trouble. How much time and how much trouble remains to be seen. Cancer study is a problem in applied science which needs the united efforts of chemist, physicist, cytologist and biologist, and this cooperative and coordinated union in scientific effort is as much the product of American adaptability as is quantity production in manufactures. This united effort implies no deterioration in quality from so-called pure science, and is the united determination to solve a problem, even such a difficult one as cancer, by the assemblage of knowledge and mutual cooperation of scientific men and women.

DR. HILLEBRAND AS I KNEW HIM[1]

By Dr. E. T. ALLEN

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THE purpose of this occasion is to honor achievement, past and present. A more fitting memorial to Dr. Hillebrand could not have been conceived. We think of him as a man of achievement; other aspects of his comparatively uneventful life would have little interest for us.

In recalling briefly the outstanding formative influences of his career, those early years in Honolulu come to mind. Dr. Hillebrand was born in the Hawaiian Islands, less than a century after the white man first set foot on those shores. But if the circumstance of that early environment left any permanent impress on his temperament or his imagination, I have been unable to find it. Dr. Hillebrand rarely alluded to this period of his life. It seems to have been but an episode.

Dr. Hillebrand's father was a German physician who came to Honolulu for his health. He became deeply interested in the luxuriant tropical plant life about him; studied it; became an authority on the subject, and is to-day I believe the classic authority on the botany of the Hawaiian Islands. Dr. Hillebrand once told me that he had accompanied his father on many of his botanical expeditions, but that he never became interested in botany. However, the fact that his father was an intellectual man, of broad training, with the ability and the initiative to make himself an authority in any branch of science, must, I think, be counted an important influence in the after life of his son.

Dr. Hillebrand's formal education was unusually complete. After two preliminary years at Cornell University, he was sent to Germany in the early seventies, where he remained for six years. He studied at Strassburg and at Heidelberg. At Heidelberg, where he took his degree, he became a pupil of Bunsen and of Kirchhof, colossal figures in the world of science then, as they are to-day. Twenty-five years ago, as chairman of the program committee of this society, I prevailed upon Dr. Hillebrand to give us his recollections of Bunsen. He regretted that much of a personal character had faded from his memory, but he left no doubt in the minds of his listeners of the profound respect he bore to Bunsen and the powerful influence Bunsen had exerted on his own career.

To the German university Dr. Hillebrand doubtless owed much besides his purely technical training; ideals of thoroughness, accuracy and breadth. While perhaps not a man of the widest interests, he had a very broad perspective, much broader, I should say, than that of the ordinary professional man. Much of this, I think, was derived from the grand precept of the German university, that any department of human knowledge, no matter what its popularity, was entitled to the same respect as every other.

At Freiberg Dr. Hillebrand attended one of the most famous mining schools in the world, where he was grounded in such subjects as geology, assaying and metallurgy (metall'urgy, as he always called it after the German pronunciation).

In 1879, we find Hillebrand in Leadville, Colorado, one of the important ore-producing centers of the day, where he worked as an assayer. Shortly afterwards he joined the Geological Survey and a little later came to Washington where he remained in the government service to the end of his life.

I first met Dr. Hillebrand thirty years ago at the old Hooe Building on F Street, then occupied by the Geological Survey, since razed to make room for the National Press Club. Had you called on Dr. Hille-

[1] Delivered before the Chemical Society of Washington on the occasion of the award of the Hillebrand Prize to C. S. Hudson, March 26, 1931.

brand at that time, you would probably have come away with the feeling that he was not a very aggressive man, not especially social or entertaining, but refined, dignified and distinguished. On further acquaintance you would have found him pleasant in his personal relations and thoroughly satisfactory to cooperate with; a man of the highest integrity and conscientiousness. If you had had opportunity to watch him at his work, you would have been apt to find him sober, silent and absorbed. While not a man habitually gloomy, he was not noted for cheerfulness, optimism, exuberance or even enthusiasm. His most loyal friend would never have thought of proposing his name for the Rotary Club.

One of Dr. Hillebrand's outstanding qualities was intellectual honesty. I have rarely known a man so little apt to misrepresent or overstate the facts in order to score in an argument, or to overemphasize the importance of his own work.

A man essentially judicial in temperament, deliberative but not slow, he has surprised me by the speed with which he would grasp the gist of a scientific article; and in the laboratory work of the department none of his coworkers ever equalled his output.

For many years a pillar of this society, Dr. Hillebrand was not much inclined to join in its discussions, except perhaps when they concerned the American Chemical Society, and he never "gave talks." He habitually read from the manuscript papers carefully worked out. His distinguished figure, with the massive head and flowing beard, will not soon be forgotten.

In choosing analytical chemistry as his life work Dr. Hillebrand entered an old, old field and he usually approached it by well-worn paths. Not an innovator in the usual sense, he invented few new methods, devised little apparatus useful in his art. He will be remembered chiefly as a refiner and systematizer. Two important principles, neither of which was new with him, he was very fond of applying. One was the principle of double precipitation in gravimetric separations. Before reading Hillebrand's book I had thought of double precipitation as something to be used only in work of unusual accuracy, in especially skilful hands; otherwise just another opportunity for mechanical losses. From Hillebrand I learned that in many of the commonest separations, that was the wisest course to pursue. My ideal analytical method had been one that combined optimum conditions, suitable for all possible proportions of the two elements to be separated. Hillebrand convinced me that few such methods exist; but that by a single precipitation one could always come to the same case, namely, a great excess of the element to be determined and a minimum amount of the other. This case can be very easily handled.

Corrections have doubtless been applied to scientific measurements since early times, more frequently in those sciences where the measurements are characterized by a larger mechanical factor than they are in chemistry. Outside of special researches they had not been much used in chemistry before Hillebrand's time. He taught the importance of systematic corrections in all chemical work that made any pretension to accuracy.

It may interest some of you to know that Hillebrand attached no special importance to his manual skill. He once said that if he had any advantage over other men in his profession, it was not by reason of his skill of hand, but because of his broader experience—and, he might have added, his intelligence.

There was one circumstance in Dr. Hillebrand's environment at the Survey which might have seemed, to an outsider, a handicap, but which really proved an advantage to him. As long as he stayed at the Survey, despite the standing he had in his profession, he was always subject to call, for a certain amount of routine work. But this he made an opportunity for trying out his methods under all sorts of conditions and thereby bringing them to a higher state of perfection.

As a systematizer also, it seems to me, we owe much to Hillebrand. In a good course in qualitative analysis, if the student learns anything, it is *system*. In quantitative analysis, as formerly taught, he was given a book of fragmentary recipes. If he wanted to make a complete analysis, especially of some complex substance, he found no clear and logical course to follow. Hillebrand makes the course clear.

I have said that Hillebrand was not an innovator in the usual sense. Shakespeare was not much of an innovator. His plots are generally taken from earlier sources. Very little changed, you may find many of them in the works of the old chroniclers. Much of the dialogue in some of his plays may be found in Plutarch. Yet Shakespeare did something to those old stories. He didn't invent them; he transformed them. Not to the same degree, of course, but still in a very true sense I think it may be said that Hillebrand transformed the methods that he made his own. Taking many of his materials from the junk heap of tradition, he shaped them to his purpose and formed from them a tool which he sharpened into a precise instrument of wide application.

This is not all that Dr. Hillebrand did. He made important contributions to mineral chemistry. Later at the Bureau of Standards he began with Lundell a work of broader scope. But if he had done nothing

but his analytical methods, his fame I think would still be secure.

From conversation with Dr. Hillebrand many years ago, I learned that, even as a boy, he felt a strong predilection for chemistry. He apparently had a bent from which he was not to be turned aside by the allurements of botany or metallurgy. He followed that bent, and by the least spectacular of methods he achieved distinction.

This society may be said to have possessed its fair share of men whose work is of more than average merit, but I doubt if there is any other who has produced anything that is so often and so widely used as Dr. Hillebrand's analytical methods.

OBITUARY

MEMORIALS

AN international committee has been formed to establish a memorial to the late Albert Brachet, professor of anatomy and embryology in the University of Brussels, who died on December 27, 1930.

A correspondent writes: "Professor Brachet was noted for his work in the embryology of vertebrates and more particularly for his experiments on the early phases of development of the amphibian egg. His good sense, devotion and unusual personal charm won for him a high place in the councils of science and education. American colleagues who met him on his extended tour of the United States two years ago will long cherish his memory." The American members of the committee are: Professor E. G. Conklin, Princeton University; Professor Ross G. Harrison, Yale University; Professor F. R. Lillie, University of Chicago; Professor T. H. Morgan, California Institute of Technology; Professor E. B. Wilson, Columbia University.

The committee is asking for subscriptions to a fund to be used (1) to found a triennial or quadrennial prize, to be awarded for the best work appearing during that period in the field of embryology, especially that of causal embryology, open to the entire world and to be awarded by the Belgian Academy of Sciences, and (2) to place a memorial tablet to Professor Brachet in the entrance hall of the Institute of Anatomy in Brussels. To subscribers of one hundred francs or more a reduced replica of the medallion will be given. Student subscribers will receive the replica for gifts of fifty francs or more.

Subscriptions should be sent directly to MM. Philippson, Banquiers, 44 rue de l'Industrie, Brussels, Belgium, and marked "Manifestation Brachet."

WE learn from the *Journal* of the American Medical Association that a memorial auditorium named in honor of the late Dr. Henry Mills Hurd, for many years superintendent of the Johns Hopkins Hospital, is now in construction on the hospital grounds. The building, which will seat 200 persons with standing room for an additional 100, will be completed in the fall. A part of the equipment will be a device for projecting pictures from underground rather than from the rear. Thus the lecturer may illustrate with living models, without their appearing in view of the audience. The Hurd memorial was the gift of Mr. George K. McGraw.

A COMMITTEE of university professors is preparing the material for the publication of the "Complete Works" of Lazzaro Spallanzani, which will contain all the writings, published and unpublished, of the great biologist. It will not be a "critical edition" but will contain material calculated to show what is due to Spallanzani as regards the priority of scientific observations and discoveries. The first two volumes will be issued on the occasion of the International Congress of Physiology, which will be held in Rome in 1932.

THE review *Scientia* pays tribute to the memory of its late director, Dr. Eugenio Rignano, by founding a prize to be conferred after international competition upon the author of the best essay on "The Evolution of the Notion of Time."

RECENT DEATHS

DR. ARTHUR STARR EAKLE, professor of mineralogy at the University of California, has died in Honolulu at the age of sixty-seven years.

DR. WILLIAM JASPER SPILLMAN, agricultural economist of the U. S. Department of Agriculture, died on July 11. He was sixty-seven years old.

DR. EUGENE LYMAN FISK, medical director of the Life Extension Institute, New York City, died on July 6 at the age of sixty-four years.

THE death is announced of Dr. Harold E. Bemis, professor of veterinary surgery and obstetrics and dean of the School of Veterinary Medicine of the University of Pennsylvania.

SIR CHARLES HENRY BEDFORD, of Woking, England, formerly editor of *The Indian Medical Gazette* and professor of chemistry in the Medical Colleges of Calcutta and Lahore, died on July 8 at the age of sixty-five years.

Nature reports the death of C. T. Heycock, F.R.S., Goldsmiths' reader in metallurgy in the University of Cambridge, on June 3, aged seventy-two years; of Mr. W. F. Denning, authority on meteors and comets, on June 9, aged eighty-two years, and on June 9 of Dr. R. C. Macfie, author of works on biology, Thomson lecturer in the University of Aberdeen for 1929.

SCIENTIFIC EVENTS

THE ALBERT NATIONAL PARK IN THE CONGO

A CORRESPONDENT of *The Geographical Journal*, London, describes the Parc National Albert of the Kivu District of the Congo, which was created mainly for the protection of the mountain gorilla. It was established by Royal Decree on 21 April, 1925, and consisted of 60,000 acres, including the three volcanoes, Mikeno, Karisimbi and Visoke. The area made a splendid wild-life sanctuary. Its remarkable volcanic structure and conformation gave it a special geological and geographical interest. It possessed a flora of exceptional richness and variety ranging from that of the tropics at the mountain foot to that of the alpine meadow near the snow-line. Its fauna was equally varied and peculiar, especially in its possessing the greatest of the apes and the animal most nearly related to man. Its native inhabitants were a pygmy race unusually primitive and interesting to anthropologists. By a later Decree of 6 May, 1929, the Parc was greatly enlarged and placed under the control of an International Commission. It now consists of 500,000 acres divided into four reserves or sectors. It is forbidden under penalty of fine or imprisonment to pursue, capture or molest any animal within these reserves. It is also forbidden to take or destroy the nests of wild birds, to cut down or remove any uncultivated plant, or to alter in any way the natural surface of the country. To the four reserves comprising the main Parc there have been added certain adjacent territories to serve as buffer zones. The restrictions in these zones are less severe. Hunting by visitors is strictly prohibited in them, but the natives are permitted to use their primitive weapons in order to kill animals for food. The International Commission that controls the Parc consists of eighteen persons, of whom one third are chosen from among the members of foreign institutions. The British representatives on the Commission are Viscount Grey of Fallodon and the Earl of Onslow. The Parc National Albert is therefore an international institution and a very practical example of how different countries can combine in the work of protecting Nature. An important feature in the Parc National Albert is that it is designed not only for the preservation of Nature, but also as a place for scientific study. It is hoped that students from all over the world will use it for biological and other investigations. There are now two great sanctuaries in Africa established by law on that rigid foundation which alone gives hope for their long survival. One is the Kruger National Park of the Transvaal; the other is the Parc National Albert of the Congo.

THE HYGIENIC EXPOSITION IN DRESDEN

THE International Hygienic Exposition, which reopened on May 6, is arranged this year, according to a correspondent of the *Journal* of the American Medical Association, to make a more immediate appeal to the layman. An attempt has been made to avoid unduly technical terms and statements, without yielding anything from the standpoint of clearness and accuracy. An entirely new section "Diagnosis and Treatment" reveals the thoroughness, the complex nature and the heavy responsibilities of the medical profession. The set-up brings out that only the physician, who knows the normal body thoroughly, can recognize and cure pathologic departures from normal. It is the opposite of the exhibit presented last year, which revealed the manifestations of quackery and superstition. The management has enlarged a section that awakened particular interest, namely, habit-forming drugs. The results of morphinism, cocainism and excessive addiction to products bearing nicotine are clearly depicted. In the two first addictions, it is plainly emphasized that addicts are actually ill and must be treated as patients; in the case of nicotine and alcohol addiction that conclusion was avoided. A section termed "health in figures" has the purpose of teaching a correct understanding of medical statistics. With the aid of statistics, sources of error may be exposed that sometimes creep in and disturb a mathematical conception of diseases, thus leading to pessimism whereas actually optimism is in order. Figures showing an apparent increased incidence of certain diseases have often their basis in the fact that new means and methods of diagnosis make possible an earlier and more precise recognition of a disease. Especial interest attaches to the model hospital of eighty rooms, which contains a radium department that has few if any equals. The broad field of industrial hygiene has been completely reorganized. A miniature mine exhibits the large number of arrangements and devices to protect the lives and the health of workmen. The participation of foreign countries this year is gratifying. Austria, Czechoslovakia and France have reorganized their exhibits in a satisfactory manner, having added considerable new material. Several new exhibits have been installed by the Deutsches Hygiene-Museum; constant improvement and modernization are characteristic of this museum.

RESEARCH PROGRAM OF THE ILLINOIS STATE GEOLOGICAL SURVEY

THE Illinois State Geological Survey, by virtue of the action of the State Board of Natural Resources

and Conservation, supported by appropriations made by the last General Assembly and Governor Emmerson, is undertaking an extended program of research which will begin with the occurrence of raw mineral materials in the ground and end with industrial research on utilization and marketing. The program recognizes the need of eight lines of endeavor: (1) special projects to furnish information or solve certain problems of current importance, (2) continuing projects that gradually increase the fund of general information regarding the geology, mineral resources and mineral industrial history of the state, (3) fundamental research into the stratigraphy and structure of the geologic systems of strata, (4) fundamental research into the constitution of the various earth materials, with emphasis on those that are basic to industrial development, (5) chemical and physical research on industrial utilization, (6) study of the flow of minerals into and out of the state and of the trends of the industries as affected by discoveries of new resources, new uses, and new or improved methods of processing, (7) provision of information to the general public, the industries and the various departments of state government, and (8) educational extension and dissemination of knowledge concerning the geology of the state accumulated during the past twenty-six years of investigations, for the benefit of the laymen and the science teachers in the public schools.

The State Geological Survey will now comprise a geological resource section of geological specialists in coal, non-fuels, oil and gas, subsurface data, areal geology, engineering geology, sedimentary petrography, stratigraphy and paleontology; a geochemical section of specialists in organic, physical, analytical and industrial chemistry, and a geophysicist in the broader sense; and a mineral economics section. All these will be supported by the necessary stenographic, clerical and editorial staff. Cooperative topographic mapping with the U. S. Geological Survey will continue on the same scale as heretofore, each organization contributing $50,000 per year.

The urgent need for such an organization of the Illinois Geological Survey to carry out effectively the type of program outlined, was recognized by the mineral industries, engineering organizations, business interests and state officials, and particularly is the need for it evident during the present depression. Fairly adequate appropriations amounting to a total of about $470,000 for the biennium were therefore made by the legislature and the governor.

THE BUFFALO MEETING OF THE AMERICAN CHEMICAL SOCIETY

THE eighty-second meeting of the American Chemical Society will be held in Buffalo, New York, from August 30 to September 4. From the tentative program, as given in *Industrial and Engineering Chemistry*, we learn that the registration office at the Hotel Statler will be open on Sunday, August 30, from 4 to 8 p. m., and from 8 a. m. on the following days. At 2 p. m. on Monday there will be a general meeting at Hutchinson High School Auditorium and a symposium under the auspices of the Division of Industrial and Engineering Chemistry on "New Research Tools," under the chairmanship of Dr. Karl T. Compton. Those taking part are expected to include F. G. Cottrell, E. M. Chamot, R. B. Sosman, F. G. Keyes, W. A. Peters, P. K. Frölich, S. Dushman, W. H. Rodebush, C. P. Smyth, D. H. Andrews, G. L. Clark and J. B. Nichols. In the evening at 7 p. m. there will be a subscription dinner, and a reception by the officers of the society, followed by dancing and cards.

Tuesday and Wednesday will be devoted chiefly to divisional meetings and to group dinners and luncheons. On Wednesday evening at 8:30 p. m. Professor Moses Gomberg, of the University of Michigan, will deliver the address of the president on "Valence Variation and Atomic Structure," followed by the initial presentation of the Langmuir award and of the J. F. Schoellkopf Medal. Divisional meetings will be continued on Thursday and inspection trips will be made to the Buffalo Foundry and Machine Company, makers of chemical equipment, and the Dunlop Tire and Rubber Company. There will also be a sightseeing trip to Niagara Falls with transportation by high-speed trolleys. This trip will include an optional visit to the Niagara Falls Power Company's model of Niagara Falls, a trip through the power house on the American side of the Falls and a trip around the Gorge Route. Visitors will assemble about 5:30 for a festival at Victoria Park on the Canadian side, where a picnic supper will be served. The festival will include music, exhibition sports contests and a special illumination of the falls.

On Friday optional inspection trips are planned to the Tonawanda Paper Company, showing some of the largest paper machines in the world; the Consolidated Aircraft Corporation, where the latest commercial models of planes will be exhibited and demonstrated; the Flexlume Corporation, manufacturers of neon signs and illuminated signs; the Curtiss Aeroplane Company, working exclusively on government orders for planes, and Huntley Station of the Buffalo General Electric Company, an unusual steam power plant.

All the divisions will hold sessions at Buffalo and a number of joint meetings and symposia have been planned. The Division of Biological Chemistry will hold a joint session on Tuesday afternoon with the Division of Agricultural and Food Chemistry and on

Wednesday morning with the Division of Medicinal Chemistry on "The Biochemistry of the Fats," with W. R. Bloor, G. S. Jamieson, W. E. Anderson, R. J. Anderson, W. M. Sperry and L. H. Newburgh as speakers. On Thursday morning it will take part in a joint symposium on endocrines with the Division of Medicinal Chemistry.

The Division of Chemical Education will hold a joint symposium with the History of Chemistry Division on "The History of Chemical Education in America." This is being planned as a memorial to Edgar Fahs Smith, first chairman of both of these divisions. "The History of Chemistry in America from 1820 to 1914" will be divided into four periods, with Lyman C. Newell, C. A. Browne, Harrison Hale and F. B. Dains as speakers. Wednesday afternoon will be devoted to a symposium under the general topic, "Visual Aids in Chemical Education," with papers by invitation only. High-school classes everywhere are invited to send exhibits to the divisional meeting at Buffalo.

In addition to the symposium on "New Research Tools" the Division of Industrial and Engineering Chemistry will hold a joint meeting with the Divisions of Petroleum Chemistry and Gas and Fuel Chemistry. The Division of Petroleum Chemistry will also hold a joint symposium with the Division of Gas and Fuel Chemistry and the Division of Industrial and Engineering Chemistry on the "Utilization of Gaseous Hydrocarbons." Professor Donald B. Keyes will act as chairman of this symposium.

A symposium on "Kinetics of Reactions" has been arranged by the Division of Physical and Inorganic Chemistry for Tuesday morning, which will probably extend through Tuesday afternoon.

The Division of Dye Chemistry expects to hold a three-session meeting divided into three topics: one devoted to spectrophotometry, including papers on the various color analyzers and possibly an exhibit of the latest instruments; another on certain theoretical aspects, and the third given over to the usual miscellaneous papers.

The divisional officers will meet for breakfast on September 2 with Erle M. Billings presiding and Frank C. Whitmore acting as secretary, and the local section officers on September 3 with H. T. Herrick presiding and with Ellice McDonald as secretary.

IN HONOR OF JOHN R. FREEMAN

ACCORDING to the *American Engineering Council Bulletin,* the Providence Engineering Society recently gave a testimonial dinner in honor of John R. Freeman, which was attended by approximately three hundred engineers. Greetings, congratulations and messages of respect were received from engineers and engineering organizations all over the world. The speakers were:

Mr. Charles T. Main, past president of the American Society of Mechanical Engineers; Frank E. Winsor, vice-president of the American Society of Civil Engineers; Professor Charles F. Scott, past president of the American Institute of Electrical Engineers; Professor Charles W. Brown, representing the Geological Society of America; the Rev. John Joseph Lynch, of Fordham College, representing the Seismological Society of America; Benjamin Buttolph, vice-president of the Manufacturers Mutual Insurance Company, representing the Factory Mutual Fire Insurance Companies; Dr. Clarence Barbour, president of Brown University; H. E. Sawtell, president of the Boston Society of Civil Engineers; Blake R. Van Leer, assistant secretary of American Engineering Council, representing the John R. Freeman scholars; Chester T. Morey, president of the Providence Engineering Society; Walter Humphreys, representing the corporation of the Massachusetts Institute of Technology; Governor Norman S. Case, of Rhode Island, and Senator Hebert, who read a message from President Hoover.

Professor Charles F. Scott, speaking as the representative of the American Engineering Council at the testimonial dinner, said:

I have been delegated by the American Institute of Electrical Engineers to bring its greetings to the Providence Engineering Society and to extend its aid in doing honor to Mr. Freeman.

During your active engineering life, Mr. Freeman, you have stood for progress in engineering art and practice, and have labored to make engineering achievement of greater service to mankind. During this same half century the electrical engineering group has pioneered a new field of engineering which has contributed a universal power service for relieving the burden of toil, and has created new means of communication, a new tool for intellectual intercourse, and it is therefore particularly fitting that a group so sympathetic with your aims and achievements as a practicing engineer should be privileged to do you honor on this occasion.

I am commissioned also to bring the greetings of the American Engineering Council. You have been more than a technical, practicing engineer; you have been a "citizen" engineer, you have had a high ideal of the engineer in public service. It is this ideal which has taken concrete form in the American Engineering Council, the common agency of many engineering societies, with common endeavor. These representatives of many technical fields and geographical districts join in rendering engineering service in public affairs.

I might, I think, concisely and adequately define American Engineering Council as an organization for putting into effect the public service ideals of John R. Freeman. And so it is peculiarly fitting that the council should on this occasion do honor to the man whose ideals and whose acts proclaim him as a notable representative of the highest and broadest type of engineer, and as one who has lived to serve his fellowmen.

SCIENTIFIC NOTES AND NEWS

DURING the business meetings of the Pacific Division of the American Association for the Advancement of Science, held in Pasadena, from June 15 to 20, Professor A. O. Leuschner, of the University of California, was elected to the presidency of the division for the ensuing year. Dr. H. D. Babcock, of the Mount Wilson Observatory, was elected to membership on the Executive Committee in succession to Professor L. B. Loeb, who is retiring after five years of service. Under invitation from the State College of Washington the selection of Pullman, Washington, for the sixteenth annual meeting of the division and its associated societies was approved. In all probability the meeting will be held during the week of June 13, 1932.

THE provisional program of the James Clerk Maxwell Centenary celebration, to be held at the University of Cambridge on October 1 and 2, has been made public. There will be a memorial lecture by Sir J. J. Thomson, the master of Trinity College; addresses by Professor Planck, Professor Sir Joseph Larmor, Professor Langevin and Sir James Jeans. Receptions, a luncheon, conversaziones in the Cavendish Laboratory, an at home by the new Vice-Chancellor and Mrs. Spens, and a dinner at Trinity College have also been arranged.

THE honorary degree of LL.D. has been conferred by the University of Glasgow on Sir F. G. Hopkins, president of the Royal Society, and on Professor C. U. Ariëns Kappers, professor at the Central Institute for Brain Research, Amsterdam.

DR. HUGH H. YOUNG, director of the Brady Institute of Urology of the Johns Hopkins University, has received the degree of doctor of science from Queen's College, Belfast.

DR. J. SHELTON HORSLEY, ex-president of the Medical Society of Virginia and of the Virginia Academy of Science, received the honorary degree of LL.D. from the University of Richmond at its commencement exercises. Dr. Horsley was formerly professor of the principles of surgery at the Medical College of Virginia.

DR. ROSS V. PATTERSON, dean of Jefferson Medical College, Philadelphia, and president of the Medical Society of the State of Pennsylvania, received the honorary degree of doctor of science at the dedication of a new group of buildings at La Salle College.

THE degree of doctor of science was conferred on the Reverend Dr. George H. Richardson, rector of Christ Church, Lead, South Dakota, by Yankton College at its commencement on June 10, in recognition of his work in paleontology.

THE South Africa Medal for 1931 has been awarded to Professor H. B. Fantham, of the department of zoology and comparative anatomy in the University of the Witwatersrand, Johannesburg, for his researches on parasitic protozoa, soil protozoa and heredity.

AT the recent meeting of the British Institution of Gas Engineers medals were conferred as follows: Birmingham Medal, 1931, to Mr. Thomas Hardie, chief engineer of the Gas Light and Coke Company, for his work on behalf of the industry; the H. E. Jones London Medal, 1930, to Mr. Edward G. Stewart, of London, for his paper on "The Functions of Coke Ovens"; the Institution's Silver Medal, 1930, to Mr. A. L. Holton, chief engineer, Manchester Gas Corporation, for his paper on "The Utilization of Coke Breeze by the Trefois Process," and the Institution's Bronze Medal, 1930, to Mr. S. K. Hawthorn, Birmingham, for his paper on "Oxide Purification."

DR. R. W. DODGSON, of the British Ministry of Agriculture and Fisheries; Dr. C. M. Yonge, of the Marine Biological Association Laboratory at Plymouth, England, and Dr. John Eyre, of Guy's Hospital, London, are to be guests of honor at the annual joint meetings of the Oystergrowers and Dealers Association of North America and the National Shellfisheries Association at Sayville, Long Island, to be held from August 18 to 20. Scientific men, federal and state officials are expected to present papers and reports. The results of the investigations conducted for the research committee of the Growers Association, under the direction of Dr. H. D. Pease, of New York, will be shown as technical exhibits at the association's biological field station at West Sayville, Long Island.

MR. C. E. SKINNER, assistant director of engineering of the Westinghouse Electric and Manufacturing Company, has been appointed as the representative of the American Standards Association on the council of the International Standards Association. The International Standards Association is a federation of eighteen national standardizing bodies, its purpose being the systematic exchange of information on standardization work in the different countries and the promotion of uniformity among the various national standards. The council is composed of the president of the International Standards Association and six other members, each representing a national standardizing body. C. Hoenig, chairman of the Swiss national body, is now president of the association, and the six members of the council represent Italy, France, Holland, Russia, Denmark and the United States.

THE following have been elected honorary fellows

of New College, University of Oxford: Lord Donoughmore; Dr. J. B. Leathes, professor of physiology in the University of Sheffield and formerly a scholar of the college; Dr. A. E. Taylor, professor of moral philosophy in the University of Edinburgh.

DR. ARTHUR W. PROETZ, assistant professor of clinical otolaryngology in Washington University School of Medicine, has received the $500 Casselberry prize of the American Laryngological Association for notable work in his field. The award was made at the recent annual meeting of the society in Atlantic City, in recognition of research work by Dr. Proetz on sinus diagnosis and treatment. This prize was established by the late Dr. William E. Casselberry, Chicago, to be awarded for outstanding work in laryngology and rhinology.

AN oil portrait of Dr. Frank C. Hammond, who was for twenty years dean of Temple University School of Medicine, Philadelphia, was presented to the school by the class of 1929 at an alumni dinner on June 10.

DR. C. W. STILES, of the U. S. Public Health Service, completed forty years of active government service on June 30, and will go on the retired list on October 1. His address will be from October 1 to June 1, Winter Park, Florida, and from June 1 to October 1, Morristown, New Jersey.

COLONEL CHARLES F. CRAIG, until recently assistant commandant of the Army Medical Center, Washington, D. C., and late director of the Army Medical School, will be retired from the Medical Corps of the army, at his own request, after more than thirty-three years service. Colonel Craig has accepted the appointment of professor of tropical medicine at the Medical College of Tulane University, New Orleans, and head of the department of tropical medicine at that university and will take up his duties there about September 15.

THE appointment of Colonel Edward L. Munson, Medical Corps, as assistant to Surgeon-General Robert U. Patterson, with the rank of brigadier-general, for the four-year period beginning on June 1, has been announced. Brigadier-General Munson has been professor of hygiene at the Army Medical School, Washington, D. C., and professor of preventive medicine at George Washington University School of Medicine.

MR. S. C. SALMON, who has been with the Kansas State College since 1913 and professor of farm crops in that institution since 1917, has resigned and after July 1 will be principal agronomist in the Office of Cereal Crops and Diseases of the U. S. Department of Agriculture.

MR. HERBERT J. GILKEY, professor of civil engineering at the University of Colorado, has been appointed head of the newly organized department of theoretical and applied mechanics at Iowa State College.

DR. RICHARD W. LINTON has resigned as assistant professor of bacteriology in the College of Physicians and Surgeons, Columbia University, and is leaving in July for India, where he will take a position in cholera research with the Indian Research Fund Association.

DR J. J. GALLOWAY has resigned his position as associate professor of paleontology at Columbia University to accept the chair of professor of geology and paleontology at Indiana University, his alma mater. He will continue his studies in micropaleontology in his new position.

THE trustees of the estate of John W. Sterling have given $1,500,000 to Yale University for the endowment of five additional Sterling professors. One is to be allocated in the first instance to Charles Templeman Loram, chairman of the Native Affairs Commission and director of education at Natal, South Africa, who will join the graduate faculty as professor of education, with especial interest in social science; one of the professorships is assigned to Dr. James Harvey Rogers, now a member of the faculty and formerly professor of economics at Cornell University and the University of Missouri; one to Dr. Edward Sapir, formerly professor of anthropology and linguistics at the University of Chicago, and one to Dr. Oystein Ore, now professor of mathematics in the university and formerly of the University of Oslo, Norway. The fifth of the new Sterling professors has not yet been named.

PROMOTIONS to professorships in the University of Michigan include Dr. Ernest Franklin Barker in physics, Dr. Peter Olaus Okkelberg in zoology, William Platt Wood in chemical engineering, Arthur Dearth Moore in electrical engineering, Chester Owen Wisler in hydraulic engineering, Allen Firman Sherzer in mechanical engineering, Dr. Clifford Conklin Glover in pharmacognosy and Leigh Jarvis Young in silviculture.

THE following additions have been made to the staff of the New York State Agricultural Experiment Station at Geneva, effective on or about July 1: Dr. M. W. Yale, associate in research in bacteriology; A. W. Hofer, assistant in research in bacteriology; C. D. Kelly, technician in bacteriology; Dr. A. L. Shuck, associate in research in botany; Dr. Mabel Ruttle-Nebel, assistant in research in botany; Dr. H. S. Cunningham, associate in research in plant pathology; L. M. Cooley, associate in research in plant

pathology; E. C. Smith, assistant in research in chemistry, and R. R. Jenkins, assistant in research in vegetable crops. In addition, on July 1, Dr. C. S. Pederson was promoted from associate to chief in research in bacteriology, while J. C. Marquardt and W. F. Walsh were promoted from assistants in research to associates in research in dairying and chemistry, respectively.

PROFESSOR WILLIAM H. HOBBS, professor of geology at the University of Michigan, will sail for Europe on August 22 and remain on leave during the fall semester of the next academic year. He will attend the International Geographical Congress in Paris in September as the representative of the university and will participate in the excursion to the Sahara.

MR. COLEMAN S. WILLIAMS, paleontologist of the American Museum of Natural History, returned on June 23 from Argentina, bringing more than thirty cases of mammal remains of the Eocene period, unearthed in Patagonia.

To make a collection of the birds of Trinidad for the Philadelphia Academy of Natural Sciences, H. Radclyffe Roberts, of Villa Nova; George R. Clark, of Cynwyd, and W. Wedgwood Bowen, assistant curator of birds at the academy and leader of the expedition, have sailed for that island. They will spend three months exploring the tropical forests.

MR. J. R. SWALLEN, of the Grass Herbarium, U. S. Department of Agriculture, has returned from a three months' trip to Texas and northeastern Mexico. The object of the field-work was to study and collect the grasses of the region. Especial attention was given to the distribution of species in the border region of both countries.

DR. HERMAN PRINZ, professor of pharmacology in the Medical School of the University of Pennsylvania, lectured from July 10 to 15 at the University of Frankfurt.

DR. ALEXANDER VON LICHTENBERG, of Berlin, gave recently a lecture before the Royal Society of Medicine, London.

THE James A. Patten lecture in bacteriology was given at Northwestern University Medical School by Dr. Arthur Isaac Kendall, of the department of research bacteriology, on July 22. The title of the lecture was "Observations upon the Filterability of Bacteria, including a Filterable Organism Obtained from Cases of Influenza."

PRINCETON UNIVERSITY announces that provision has been made for work toward advanced degrees in mathematical physics. During the fall term of this year graduate courses in this field will be offered by Professors E. P. Adams, J. vonNeumann, E. P. Wigner, E. U. Condon and H. P. Robertson. Dr. P. A. M. Dirac, of Cambridge, will lecture on the relativistic formulation of quantum mechanics up to the Christmas vacation.

DURING the session of 1930–1931, the Mayo Foundation Chapter has held five regular meetings. The list of speakers and their subjects are Professor D. E. Minnich, department of zoology, University of Minnesota, "The Mine of an Insect"; Professor A. E. Jenks, University of Minnesota, "Excavating American Prehistoric Culture—the Unique Art of Mimbres Pottery"; Dr. J. H. Mathews, University of Wisconsin, "Scientific Methods in the Detection of Crime"; Professor Ralph Linton, "The Life of the Madagascar Native"; Dr. Walter M. Boothby, "Concepts of Relativity as Applied to Social Bridge." The officers for the coming year are: *President,* Dr. E. S. Judd; *Vice-president,* Dr. A. E. Osterberg, and *Secretary,* Dr. J. L. Bollman.

THE International Congress on Radiology meets at Paris from July 26 to 31. Mme. Marie Curie, co-discoverer of radium, is honorary president of the congress. She will be presented with the gold medal of the American College of Radiology. Standardization of such a unit of measurement is one of the principal problems to come before the meeting. Dr. Lauriston Taylor, of the Bureau of Standards, and Dr. Edwin C. Ernst, of St. Louis, will represent the Radiological Society of North America, and will be the United States members on the committee, which will consider this matter of standardization. Other delegates from the United States to the congress are: Dr. Albert Soiland, of Los Angeles, representing the American Medical Association; Dr. Benjamin Orndoff, of Chicago, representing the American College of Radiology; Dr. George Grier, of Pittsburgh, representing the American Radium Society, and Dr. George E. Pfahler, of the University of Pennsylvania, representing the American Röntgen Ray Society.

THE late Samuel Betts, patent lawyer, by his will left $426,658 to Yale University. Of this amount the residuary estate, $276,533, was left to Yale College, $50,000 to the Law School to provide books on patent law, a like sum to the Art School for use in collecting representative works by Yale graduates or other Americans distinguished in the arts, and $50,000 to the Yale University Library. $100,000 is left to the Kingsley Trust Association, otherwise known as the Scroll and Key Society, and $5,000 to the Yale alumni fund through the class of 1875.

MR. WILLIAM K. VANDERBILT'S yacht *Alva*, left Northport, Long Island, on June 7, for a voyage of exploration around the world during which specimens of marine life will be collected. Special equipment has been installed on the *Alva* for collecting and preserving the marine specimens which will be brought to the Vanderbilt Marine Museum at Centerport, where specimens gathered during the past twenty-five years are to be found. The trip of the *Alva*, which will take several months, will include the Panama Canal, Galapagos Islands, the Society Islands, Samoa Islands, the Fijis, New Hebrides, New Caledonia, Australia, the south coast of New Guinea, the islands of Flores, Java, Sumatra, Singapore, Burma, Ceylon, the Red Sea, the Mediterranean and then home by the Canaries and the Windward Islands.

DISCUSSION

THE DECLINE IN THE AVERAGE LENGTH OF LIFE

IN SCIENCE for July 26, 1929,[1] H. C. Forsyth discussed "The Decline in the Average Length of Life" and concluded that "the average length of life—or at least the expectation from age 10—is already going down. It will be noted that the expectation from age 45 to 50 is the lowest of which we have any record—and is still going down, not up." In a letter in SCIENCE for September 13, 1929,[2] Mr. J. T. Ryan criticizes Professor Forsyth's conclusions as unjustified. He explains the apparent increased mortality at advanced ages on the ground that the reduction in infant mortality and in deaths from communicable diseases (later specifying croup, diphtheria and smallpox) has postponed death in those who were thus saved. He concludes that these prolonged lives are usually sustained by diminished vitality and would therefore lower the average general health of the community. The effect of this lowered average general health of the community would manifest itself later by an increased death-rate at early advanced ages.

Apart from the question of the influence of these lives saved in early life on the lowering of the average general health of the community, which is debatable, there is a fallacy in the bases for Mr. Ryan's conclusions to which I desire to call attention.

Professor Forsyth's figures indicate an increased death-rate at advanced ages which is remarkably concentrated at age 70, although it extends back as far as age 40. The last statistics which Professor Forsyth quotes are for the year 1927. A man dying in 1927 at age 40 would have been born in 1887. The period of his infancy (first 2 years, according to pediatricians; 7 years, Oxford Dictionary) would have extended, using the larger figure, through part of the year 1894.

Fatal forms of croup are, practically without exception, diphtheria. Although diphtheria antitoxin was discovered by v. Behring in 1892, its practical production was first made possible by the work of Roux, reported in 1894. The influence of its general use, even in Boston, where its exhibition—notably in the highly efficient massive doses—was practiced earlier than elsewhere throughout the country, began to appear in the death-rate from the disease in 1899. Since the maximum mortality from diphtheria occurs at ages two to five it is evident that few if any persons dying at age 40 in 1927 could have been saved by antitoxin from diphtheria during the early years of their lives. Diphtheria prophylaxis with toxin-antitoxin or toxoid has been carried out only in recent years.

There is little evidence that the practice of vaccination had any greater influence on the mortality rate in the period 1887–1927 than during the preceding generation. Scarlet fever antitoxin was introduced in 1923. The use of convalescent serum in measles and anterior poliomyelitis is of recent development. The mortality from whooping-cough still remains high.

Finally, diarrheal diseases, which were the most potent killing agencies among the young, continued to be active up to the decade 1910–20. The growing practice of Pasteurization of milk then began to produce the most marked lowering of the death-rate among infants of any known prophylactic or therapeutic treatment for any disease. The man of 40, dying in 1927, however, could not have been helped in infancy by this procedure.

It is clear that the lowering of infant mortality or that due to the communicable diseases, upon which Mr. Ryan bases his strictures on Professor Forsyth's conclusions, could have had little or no influence on the death-rates of individuals age 40 in the year 1927, with which Professor Forsyth's study deals. If this is true for the man dying at 40 years of age in 1927, it is of course much more true for the more advanced ages and for the years preceding 1927.

If Mr. Ryan's thesis—that the lives saved in infancy will be associated with a lowered average general health at later ages and a resulting higher mortality at early advanced ages—is correct, the outlook for the future is even more serious than Professor Forsyth's paper indicated.

TIMOTHY LEARY

[1] SCIENCE, 70: 85, 1929.
[2] SCIENCE, 70: 260, 1929.

NEW PALEONTOLOGIC EVIDENCE ON THE AGE OF THE METAMORPHIC SERIES OF NORTHEASTERN WASHINGTON

THE three northeastern counties of the state of Washington—Ferry, Stevens and Pend Oreille—are covered in the main by outcrops of metamorphosed sedimentary rocks. The outcrops are in isolated fault block hills, and stratigraphic relationships are obscure. Weaver, in his report on the mineral resources of Stevens County,[1] divides the sediments into twenty-one formations, all included in the Stevens series. This is a thick series of alternating argillites and quartzites with lenticular beds of limestone. Weaver states that "the several divisions or stratigraphic members which have been grouped under the Stevens series are entirely nonfossiliferous."[2] On the basis of possible lateral continuity with the Pend Oreille series of British Columbia he states that the upper members of the Stevens series are of the same age, possibly upper Paleozoic, and that the lower members of the Stevens series may represent the lower and middle Paleozoic.

Very little has been added since to this statement of age. Previously, Shedd had stated that the only locality in the limestones of eastern Washington where he knew of fossils being found was in the undifferentiated limestones north and east of Springdale.[3] The fossils appeared to be corals. Some crinoid stem segments have been found near Republic, Ferry County. From the coral and crinoid remains and from the apparent relationships of the Stevens series with beds in British Columbia, the age of the Stevens series has been given as Carboniferous, at least in part.

Dr. Culver and Dr. Jones, of the State College of Washington, have brought in some additional fossils from the Stevens series, and these give definite evidence of the age of the deposits. One collection was blasted from the undifferentiated limestone six miles north of Chewelah, Stevens County. The limestone is reddish in color, dense, sandy, and bears thin lenses of impure argillite. Specimens of *Kutorgina cingulata* (Billings) are abundant and a few fragments of free cheeks of trilobites occur. *K. cingulata* is confined to the Lower Cambrian in its numerous occurrences, so it is certain that this portion of the Stevens series is Lower Cambrian in age.

The Mission argillite occurs two miles east of Daisy, Stevens County. Two specimens of a pelecypod were found there. These appear to belong to the genus *Paleoneilo*, which is most common in Devonian rocks, but which ranges to Triassic. Some graptolites of the *Monograptus* type were found in the Mission argillite north of Colville, Stevens County. *Monograptus* is confined to Silurian and Devonian rocks, and this occurrence, together with the occurrence of *Paleoneilo*, indicates Devonian age of the Mission argillite. A coral from the undifferentiated limestone north of Colville appears to be a *Favosites*. Some *Fusulina*-like foraminifera were found in the same area.

It seems quite possible that the metamorphic series of northeastern Washington represents most of the Paleozoic periods, and that careful search in the area will disclose definitive fossils in most of the members of the Stevens series.

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[1] C. E. Weaver, Washington Geol. Surv., *Bull.* No. 20, 1920.

[2] *Idem*, p. 52.

[3] Solon Shedd, Washington Geol. Surv., *Bull.* No. 4, p. 123, 1914.

THE BASAL-METABOLIC RATES OF VEGETARIANS

THE work of Benedict and Roth[1] published in 1913 indicated that there is little, if any, difference between the basal-metabolic rates of vegetarians and non-vegetarians.

Consistent sub-normal results for the basal-metabolic rates of long-time vegetarians led the writers of this paper to present the following data:

The group chosen for intensive study consisted of girls—nurses in training at a vegetarian sanitarium—between the ages of eighteen and twenty-five, and living under uniform conditions of diet, work and general environment. No subjects who were more than 10 per cent. over or under weight, or who showed symptoms of poor health or other abnormality, were included in the group. The determinations were all made with the same apparatus and at the same time of day, before the girls left their beds in the morning. The Du Bois standards of normality were used as the basis of comparison.

Five girls were classed as life-long vegetarians, having never eaten meat of any kind in their lives. Their average basal-metabolic rate was 14 per cent. below the normal of Du Bois. Ten girls were classed as long-time vegetarians, having been non-meat-eaters for five years or more. Their average basal-metabolic rate was 12 per cent. below normal.

As a check on this work, the basal-metabolic rates of twenty-six non-vegetarian girls were determined, with the same apparatus and under conditions as nearly parallel as possible. Their average basal-metabolic rate was 4 per cent. below normal.

Comparison of these results with the basal-metabolic rates of short-time vegetarians seems to show that

[1] *Jour. Biol. Chem.*, 20: 231, 1913.

a long period of vegetarianism is necessary if the rate is to be noticeably reduced.

A fuller account of this work will appear elsewhere.

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REACTION OF THE CONTENTS OF TRICHINELLA SPIRALIS CYSTS

THE late Dr. Allen J. Smith, former professor of pathology in the University of Pennsylvania, added crushed *Trichinella spiralis* (Owen) cysts from a human muscle to ordinary agar medium tinted blue with litmus indicator. The cysts were found in a portion of the pectoral muscles of a badly infested human cadaver (U. of P. Path. Mus. 37) in the dissecting room. There resulted a pink color indicating an acid reaction. He suggested to the writer, in 1925, to carry on this unpublished work and endeavor to determine the reaction of the contents of such cysts in rats.

Feeding rats with trichinosed meat, secured through the late Dr. B. H. Ransom, of the Bureau of Animal Industry, Washington, heavy infestation was secured in one month. It was deemed advisable to allow three months to pass before beginning work on them. Numerous cysts were found after lapse of that period, the regions of highest infestation being the diaphragm and intercostal muscles. The nematode larvae were found singly in the cysts, which measured 0.33 x 0.16 mm. The rats became fat and exhibited all the signs of general well-being.

Upon ordinary agar medium, having phenolphthalein indicator over the surface, were placed twelve capsules. They were then crushed between two needle scalpels and it was observed that the indicator turned pink—showing the presence of an alkali. This was repeated with the same result.

To the contents of other cysts crushed on agar Rosolic acid indicator was added. This resulted in a pink color, after a half-day well protected from the air. This acid indicator has a pH range of 6.9–8.

A series of Clark and Lub's sulfonphthalein dibasic acids were employed as a comparator set to determine the pH. This resulted in failure. The indicators are too delicate to enable one to note color changes under the microscope. Crushed cysts on a white china dissecting plate and on plaster of Paris impregnated with phenolphthalein indicator gave a pink color in four out of fourteen. Allowing cysts to dry, crushing them, and then adding indicator, resulted in no change.

It is evident that in order to determine the contents of *Trichinella spiralis* cysts it is not feasible to use the colorimetric method. Dr. Smith noted an acid reaction. However, these results seem to point to the presence of an alkalin substance. To check this one would need to determine if the contents would form a definite crystal that has a polarizing color reaction distinctive for some base. Some investigator with apparatus available could employ Barber's pipettes on a micro-dissecting apparatus to draw out the fluid to test. Or, better to employ an electrometric potentiometer with glass needle electrodes as has been done in entering single cells. Electrometrically one can show the exact pH, one characteristic, and a step further in determining the contents of Trichinella cysts. Its importance lies in the fact that it is not known what enables larvae to remain viable in this infective stage up to twelve years.

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SEX IN THE LOUISIANA OYSTER, OSTREA VIRGINICA

As far as the writer is aware, it has been stated by every worker in the field that the Eastern American oyster, *Ostrea virginica* Gmelin, is a dioecious species. The oyster of the Gulf Coast is considered to be identical with the Atlantic Coast form. A study of sex in the common oyster of the Louisiana coast made during 1929 and 1930 indicates, however, that although the sexes of this animal are usually morphologically separate, the oyster is regularly a protandrous hermaphrodite.

Approximately 1,000 individuals were carefully examined during the spawning season with reference to sex, size and position in relation to other oysters. Smears of the gonad of each, stained with eosin and iodine, were used in determining sex. Oysters whose gonads were destroyed by bucephalus or which contained no typical ripe sexual products were discarded, together with other oysters growing in the same cluster.

The sexes were found to be present in almost equal numbers, 371 ♂ to 373 ♀. When the ratio of the sexes was examined in relation to size, however, a striking fluctuation appeared. Of oysters 40 mm or less in body length, there were 220 ♂ to 58 ♀, while of oysters over 40 mm in length there were 151 ♂ to 315 ♀. As an even clearer illustration of this reversal, of oysters 20 mm or less in length, there were 50 ♂ to 5 ♀, while of oysters over 80 mm in length there were 7 ♂ to 48 ♀. These figures would seem to the writer to indicate that individuals of *O. virginica* first become sexually mature as males, and that with increase in size there may be a change of sex to female. This sex-metamorphosis would seem usually to occur at a body length of about 40 mm.

Further data, as given below, indicate that under certain conditions this sex-metamorphosis does not occur, and incidentally show that we are not here

dealing simply with a differential growth rate or death rate for the two sexes.

Among oysters over 40 mm in length, and growing singly, that is, not in the near neighborhood of other oysters, there were 34 ♂ to 131 ♀. Among oysters of length similar to the above, which, however, were growing in compact clusters of two or more individuals, so that the valve margins of the associated oysters were less than 40 mm apart, there were 85 ♂ to 82 ♀. Among oysters of this same length, growing in clusters, but whose valve margins were separated from those of their neighbors by 40 mm or more, there were 27 ♂ to 46 ♀. The clusters of closely associated individuals were almost always composed of oysters of dissimilar sex. Thus, the close association of large oysters seems to cause some members of the group to be male, while individuals of this same size, if growing singly, are almost all females. The figures given above dealing with clusters of less closely associated individuals indicate that the likelihood of large oysters being male decreases rapidly with increasing distance from associates.

Small oysters, no matter what their position relationships to other oysters, are almost always males.

Nine morphologically hermaphroditic individuals, irregularly placed as to size- and position-relationships, were found, an incidence of about 1 per cent.

The experimental control of the sex of oysters has been accidentally accomplished on a large scale in Louisiana, in the following manner:

Oysters growing in natural clusters are usually more than half of them males. The oyster planters of the state often break up these clusters and re-bed the individuals singly to grow for market. When these single, bedded oysters, presumably over half of them males at the time of replanting, are taken up during the next year's spawning season, almost every one is found to be a female.

A more detailed description and discussion of the data obtained is in preparation.

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CORRECTION ON PSYLLID-YELLOWS

IN the issue of SCIENCE for December 20, 1929 (lxx, 1825), on page 615, there was an article published on "Transmission Studies with the New Psyllid-yellows Disease of Solanaceous Plants." This disease was previously described by Dr. B. L. Richards, of the Utah Agricultural Experiment Station, who first associated the Psyllid insect with the trouble on potatoes. The report on the damage to the early potato crop, and the description of the symptoms on potatoes was likewise made by the same investigator. The work reported on in the article was based on Dr. Richards's first description and association of the insect with the disease.

In order to clear the confusion that exists on the original association of the Psyllid with the disease, this explanation is deemed highly necessary.

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SCIENTIFIC BOOKS

Plant Life through the Ages. A Geological and Botanical Retrospect. By A. C. SEWARD. 601 pp. 140 figs. including 9 reconstructions of ancient landscapes drawn by Edward Vulliamy. Macmillan Co., New York, 1931.

THIS book is written for the layman as well as for the student of botany and geology, and in the words of the author is designed "to illustrate the nature of the documents from which geologists have compiled a history of the earth, or at least such scraps of history as can be written from the material that is available: to give some account of the methods employed in the interpretation of the documents: and to present in language that is not unnecessarily technical a summary of the more interesting results obtained from the records of the rocks which throw light on the development of the plant world."

It is charmingly written and has a distinct literary flavor, and will undoubtedly enable many to obtain a comprehensive view of a wholly unsuspected past of the plant world. The special student will find it equally useful because very little that has been contributed to this and cognate sciences in late years has escaped the author's intellectual curiosity, as is attested by the very useful bibliography.

The general plan leads the reader from an introductory consideration of the elementary facts of historical geology, the manner of preservation of fossil plants, and the classification of plants, through a brief discussion of pre-Cambrian life and that of the earlier Paleozoic (Cambrian, Ordovician and Silurian periods), to a more detailed account of the earliest fairly well-known land plants of the Devonian. The later Paleozoic, appropriately enough since the floras in their variety and our knowledge of them is so much more complete, has three chapters devoted to its consideration. There follow chapters devoted to the Triassic, Jurassic, Cretaceous, Tertiary and Quater-

nary, and a final chapter discussing the more general questions growing out of the story related in the preceding part of the book.

Naturally in such a limited compass much must be omitted—a bare catalogue would occupy much more space—and Professor Seward has had to select, partly with a view to continuity in the narration. This is done with a skill and a lack of dogmatism which is in pleasing contrast to some of his more youthful work. The illustrations also are one of the noteworthy features of the book. Tables of geological and geographical distribution, together with maps—both distributional and paleogeographic—are added to the chapters devoted to the botanically more important periods. In all the reader is furnished with an easy and satisfactory guide which will enable him to delve as deeply as he may wish into the technical literature. Nothing that has been written on the subject approaches the present book as an introduction to professional study in paleobotany, especially in its broader and more cultural aspects.

A few slips have been noted, such as calling the Black Hills a spur of the Rocky Mountains, the locating of Staten Island off the west coast of North America, the "salt lakes in the Newark series" and the placing of the Albian stage first in the Upper and then in the Lower Cretaceous, but it is perhaps carping to mention such very minor blemishes in a work which is so exceedingly well done as a whole.

There are a number of geological concepts that are taken for granted which are open to question, particularly in the section devoted to geological cycles—a belief that has appealed to many geologists, but which is wholly subjective. Nor are the folding of strata and the elevation of mountains interchangeable terms. There is also a lack of appreciation of continental sedimentation, other than lacustrine, particularly in connection with the discussions of the Old Red sandstone, the Gondwanas, Triassic, Wealden, etc., and a too easy acceptance of red beds as indicative of arid climates. Although he does not accept it, the author might be said to flirt with the Wegener hypothesis, although, as has been frequently pointed out, its acceptance raises more difficulties—distributional and climatic, not to mention geophysical—than it solves.

It may well be doubted if there is the implied change in floras at the Paleozoic-Mesozoic boundary, and although it is perhaps wholly a matter of opinion the reviewer has grave doubts regarding the relatively late appearance of the first land floras. Paleobotanists are at present in about the state of mind on this question as were paleozoologists a couple of generations ago regarding the similar question of the time of appearance of marine life.

Despite these criticisms, the verdict must go to the author, for they are more than counterbalanced by the pleasing character and meritorious qualities of the book as a whole.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN INEXPENSIVE LIGHT SOURCE FOR A PORTABLE MICROSCOPE

WE have devised an inexpensive portable light source for a high and low power portable microscope. There are certain obvious situations in which this apparatus is of value. (a) During a surgical operation fresh frozen microscopic sections made from tissue removed while the operative procedure is in progress can be passed around among spectators and students in an amphitheater and give a vivid picture of the disease which the surgeon is trying to combat. (b) The apparatus furthermore lends itself admirably to teaching histology, pathology or biology, when occasion arises requiring a demonstration to a class of a certain feature or features in a microscopic preparation. (c) There is also possible application for the apparatus when one is doing blood or spinal fluid cell counts in a home. (d) Botanists and entomologists in field work have a need for such an apparatus.

The essential features of the apparatus are a small portable microscope, such as the Spencer Lens Company demonstrating microscope, No. 96, and a light source. (Fig. 1a). The light source is composed of a lamp and reflector from a flash light, a hinge-topped metal case, containing two standard dry cells and a rheostat switch which allows two different degrees of light, bright and dim. (Fig. 1b).

The lamp house is fastened to the base of the microscope with two screw clamps. (Fig. 1a). The flash light lamp is dissembled from the usual tubular handle and the outer collar with screw threads is soldered to the hinged lid of the lamp house. When the lid is closed, the center of the lamp makes an electrical connection, with a base plug by spring contact. (Fig. 1b). The dry cells are held in place by spring contact carriers which convey electrical energy to the rheostat switch. Resistance for this switch is formed by about 3 feet of fine annealed wire wrapped on a wood pulp spindle and insulated from the metal housing by sheet mica. The inside of the lamp housing is lined with paste board as an insulating medium.

Parts of the apparatus that will deteriorate can be bought in any electrical goods store.

The apparatus with the self-contained light source

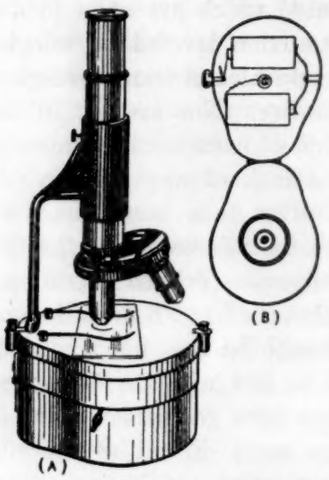

FIG. 1a. Assembled apparatus with the microscope in position on the lamp house. The hinge for the cover and screw clamp holding it in position are illustrated. The switch key is revealed well down on the side of the lamp house.

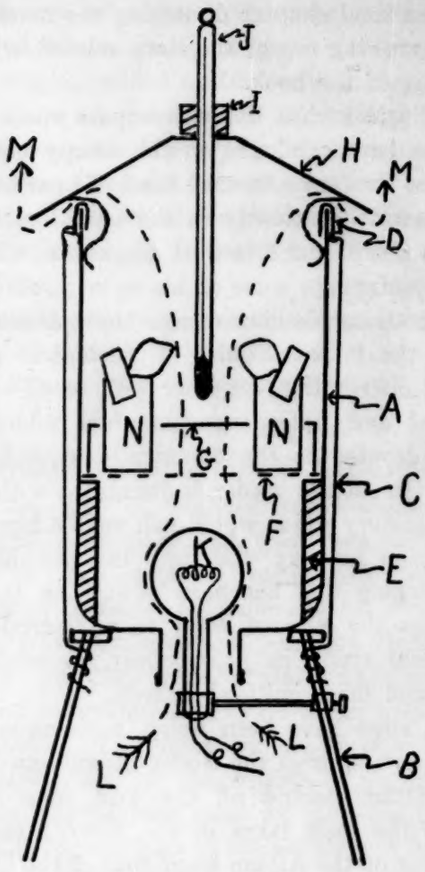

FIG. 1b. A diagram illustrating the internal construction of the apparatus. In this sketch the lamp house is opened with the hinged top lid turned down. The flash light and its center contact are shown on the inside of the lid. In the base are the two standard dry cells with their electrical connections and contact clamps with the rheostat switch and center spring contact for completion of the electrical circuit to the lamp.

is especially useful because one can view microscopic sections from any position in a room or teaching amphitheater regardless of relationship to window or other light source.

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APPARATUS FOR RAPID DRYING OF SOLUTIONS

IN determining the solubility of strontium nitrate, samples of the solution were dried in ordinary weighing bottles. As the water evaporated off, a crust was formed over the top which cut down materially the rate of evaporation. Splashing resulted when heated in an oven at 100° C. At 70° in a closed electric drying oven as long a time as two weeks was required to dry a sample. An electric oven with circulating air not being available, the simple apparatus shown in the figure was devised. It consisted of material found in any laboratory. A was a 4 litre wide mouth salt bottle. The bottom was removed by placing sulfuric acid in it to a depth of one centimeter and adding a little water. The heat developed broke the bottom out. It was inverted on tripod B and firmly held in place by means of four copper guy wires C having hooks made of bent nails at D. An annular ring of plaster of Paris was constructed at E using a cylinder of thin sheet aluminium to hold it in place. A wire gauze F was placed over the plaster to support the bottles NN. A frame of copper wire G was placed 1 cm above F. This kept the bottles from tipping over. The wire gauze permitted a free circulation of air through the apparatus. The roof H was made of a piece of a tin can. There was a space of one cm between the top of the bottle and the roof to permit the exit of air. It extended far enough beyond the sides of the bottle to prevent the access of dust. I was a rubber stopper supporting the thermometer J. K was an electric light bulb supported at such a height that air could pass freely through the mouth of the bottle. Smoke from a lighted cigarette followed the path indicated by the dotted lines L–M. A 150 watt Mazda lamp maintained a temperature of 110° C.; a 100 watt lamp, 70° C. At the latter temperature, 15 ml samples of a 40 per cent. solution of strontium nitrate (approximately saturated at room temperature) evaporated to dryness in 24 hours. This compares with the two week period in the closed oven.

A narrow strip of filter paper placed in the solution and extending above the surface of the solution facilitates evaporation without splashing. It, of course, should be dried, before being weighed with the empty bottle, in the same manner as the evaporated sample is dried before the final weighing.

Various alterations suggest themselves. A heating coil supported on a mica frame in the mouth of the

bottle can be substituted for the lamp. This gives a more uniform temperature distribution. Different materials might be used in the construction. Dried air might be passed through the apparatus. This would be advisable if working at room temperatures. However, at 70° C. the difference between the moisture holding capacity of the air and the actual moisture content of the air of the room is so large that drying the air would hasten the evaporation only slightly.

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SPECIAL ARTICLES

THERMOELECTROMOTIVE FORCES PRODUCED BY A MAGNETIC FIELD

IN studying the effects of mechanical strain and of magnetization on the thermoelectric qualities of metals, Sir William Thomson[1] saw, with characteristic insight, that these two agents affecting thermal emfs were only special cases of a more general condition. He says, "Physical agencies having directed attributes and depending (as all physical agencies we know of except gravitation appear to do) on particular qualities of the substance occupying the space across or in which they are exerted, are transmitted or permitted with different degrees of facility in different directions if the substance is crystalline." Continuing, he enlarges upon this point of view and says, "Another very general principle is, that any directional agency applied to a substance may give it different capacities in different directions for all others."

The interpretation to be put upon these statements appears to be something like this; suppose two pieces of the same metal as in Fig. 1 are joined at A. If

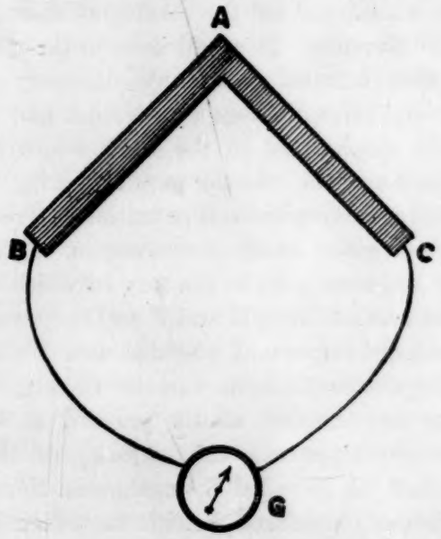

FIG. 1

AB shows properties along its length different from those along AC, they will serve as a thermocouple. For instance, if AB is crystalline with its axis extended along the length and AC has the same structure cross-wise, then if AB conducts heat, electricity or any other agent along its length differently from what AC does, these two elements will serve as a thermocouple, even though they are the same chemically.

By any means whatsoever, therefore, if we can give to AB and AC different structures so that they behave differently when placed in the path of some physical agent, we shall be able to find a thermal emf set up between the two elements. Either by stretching or by magnetizing a substance we accomplish just this effect. Thus we find a thermal emf between a stretched and an unstretched portion of a conductor.[2] We also discover a thermal emf between a permanently magnetized and an unmagnetized section of the same piece of ferromagnetic wire.[3]

A variation of this is shown in Fig. 2 where a con-

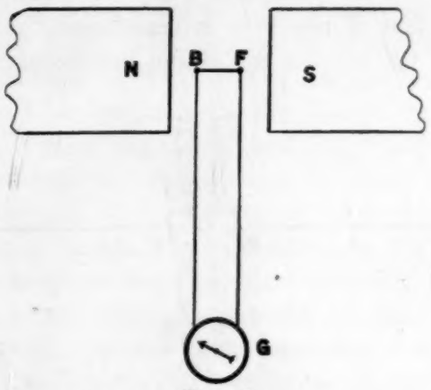

FIG. 2

tinuous iron or nickel wire is bent into a U-shaped form and placed between the poles of an electromagnet. Let one bend of the wire B be kept at the temperature of steam while the other F is maintained at freezing temperature. When the electromagnet is excited an emf occurs and a deflection of the galvanometer ensues. One may look upon this arrangement of the thermocouple as a condition in which the two elements consist of longitudinally and transversely magnetized portions. While the transversely magnetized sections, due to the very large demagnetizing factor, are not so strongly magnetized as the longitudinally magnetized portion, yet there is developed in each element a structure different from that of the other. They may, therefore, serve as a thermocouple. This was all clearly set forth by Sir

[1] Mathematical and Physical Papers, 2: 267.

[2] *Phys. Rev.*, 12: 243, 1918.

[3] *Math. and Phys. Papers*, 2: 286.

William Thomson in 1856 and has been theoretically discussed by Bridgman.[4]

Iron and nickel wires, both annealed and unannealed, have been studied in this laboratory by Wm. Ross. His arrangement of apparatus was that shown in Fig. 2. This work will appear shortly giving the details of the work. A modification is now being carried out by Stewart Seass in which the section BF of the iron and nickel wires is transversely magnetized

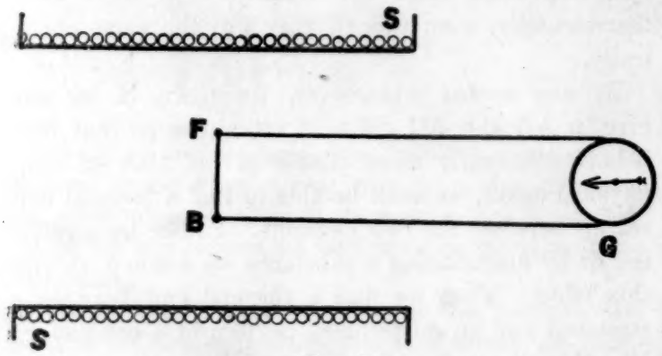

FIG. 3

by a solenoid as in Fig. 3. As was to be expected the direction of the current is opposite to that found by Ross. In the preliminary experiments by Seass it appears that if the wire is transversely magnetized all along the portion containing the junctions B and

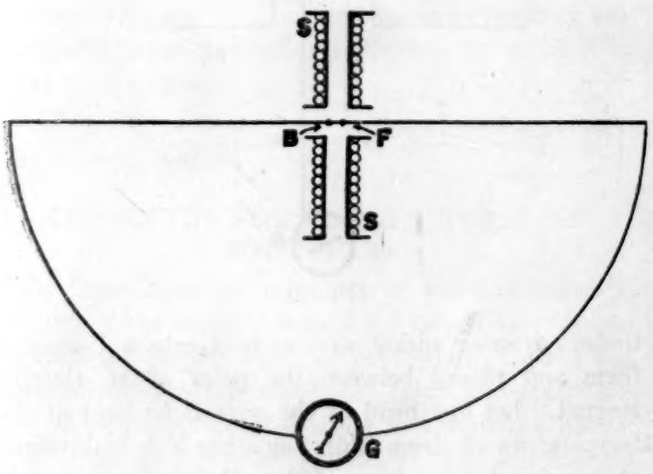

FIG. 4

F, as shown in Fig. 4, little or no emf is set up between B and F. Structurally all parts of the wire are the same, and therefore no emfs are developed. This is an important point.

In 1886 Ettingshausen and Nernst,[5] in studying the thermomagnetic effects in bismuth, came upon what they considered a new effect. If a plate of bismuth is heated at one end and kept cool at the other, as shown in Fig. 5, a magnetic field normal to the plate

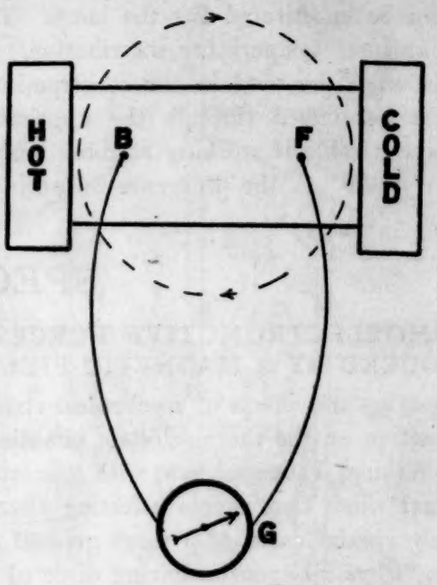

FIG. 5

and to the direction of heat flow, sets up a longitudinal emf between the points B and F. This has been called the thermomagnetic longitudinal potential difference.

If one regards carefully the disposition of the leads from the points B and F to the galvanometer, it will be seen that the Ettingshausen-Nernst effect appears to be a phase of the effect discovered by Thomson, a quarter of a century earlier.

Thomson's point of view gives some reason for the emf development in his discovery. An explanation is not so apparent when one considers the problem from the standpoint of thermomagnetic longitudinal potential difference. It would seem to the writer that this relation between Thomson's discovery and the later one by Ettingshausen and Nernst had not been sufficiently emphasized in the work which has been done on this subject. In the papers bearing upon the thermomagnetic longitudinal potential difference there seem to be a great many discrepancies. Little or no attention has been paid to the way in which the leads have been carried from B and F to the galvanometer. This is highly important and accounts for many of the discrepancies between various investigators. If there are two distinct effects present, at least one thing is very apparent, the majority of those who have studied the so-called Ettingshausen-Nernst effect have hopelessly confused it with the effect found by Thomson.

From whatever point of view one takes this phenomenon there appear to be several factors which enter to produce the resultant emf. This is a field which needs a great deal of careful investigation, both from the experimental and the theoretical sides. As Campbell[6] says, it is "a vast and fascinating

[4] *Phys. Rev.*, 31: 221, 1928.
[5] *Wiedemann's Annalen*, 29: 343, 1886. *Journal de Physique*, 6: 292, 1887.
[6] "Galvanomagnetic and Thermomagnetic Effects," p. v.

domain, wherein dwell some of the mysteries of matter."

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THE PRODUCTION OF DENTAL CARIES IN RATS FED AN ADEQUATE DIET

ONE of the difficulties encountered by those who have been engaged in dental research has been the production of caries in experimental animals. In spite of the fact that diets have been fed known to be deficient in one or more of the dietary factors considered essential for normal dental development, there has been a striking absence of caries. This fact alone is impressive and suggests strongly a lack of correlation between the adequacy of the diet from a chemical point of view and the tendency of the diet to produce dental decay.

In a study made with rats on the effect of diet on dental development, we were surprised to find caries present in the normal control animals that were receiving the stock ration used in our laboratory. This ration (yellow corn 60, whole milk powder 30, linseed meal 6, alfalfa meal 3, sodium chloride 1) has given excellent results over a period of three years and is believed to be adequate for normal dental development and dental maintenance. In contrast to this, groups of rats receiving diets characterized by a high oatmeal, low calcium and low vitamin content, gave no indications whatsoever of dental decay, even though the dental structure was relatively soft. When oatmeal was substituted for cornmeal in the stock ration, caries failed to develop. Apparently, then, the cornmeal was responsible for the decay of the teeth.

In making periodic examinations of the teeth, it was observed that impactions of cornmeal particles occurred usually in the lower molars. This was followed in a few weeks by the formation of a small cavity which encouraged more impactions and subsequently more extensive decay. In many cases a complete destruction of one or more of the lower molars has been observed. The upper molars were rarely involved and then to a much lesser degree than the lowers.

The tendency for cornmeal to become impacted has been found to be primarily a function of the size of the particle. Cornmeal passing through a sixty-mesh screen appeared to have little or no tendency to become lodged in the crevices of the molars. Accordingly, when a group of rats received the stock ration containing cornmeal of this degree of fineness, there was no evidence of decay at six months. Another group receiving cornmeal that passed through a forty-mesh screen showed slight decay at three months, and at six months the crowns of the central molar teeth were destroyed. In the case of the rats which received the fairly coarse meal as supplied by a milling concern, caries was initiated at about eight weeks and at six months practically all the lower molars were involved in extensive decay.

Attempts to prevent decay of the teeth by the addition of cod-liver oil or orange juice, supplying liberal amounts of vitamins A, D and C, or by fortifying the ration with calcium carbonate or tricalcium phosphate have been of no avail. In view of these results it is difficult to accept the theory that dental caries is due primarily to a vitamin or mineral deficiency of the diet. The results rather are in strong support of a not at all modern point of view; namely, that the cause of dental decay is the decomposition, most likely by aciduric and acidogenic bacteria, of certain foodstuffs held by the teeth in some way or other.

Those who in recent years have emphasized the importance of the diet from the standpoint of vitamins and minerals as a means of preventing caries or of checking the progress of caries in human teeth have overlooked or perhaps have ignored the fact that in changing from a deficient to an adequate diet there have no doubt been marked changes effected besides the increase in vitamin and mineral content of the diet. The inclusion in the diet of greater quantities of fruits, vegetables and dairy products necessarily reduces the consumption of those foods which, because of their consistency and chemical make-up, have a tendency to be retained by the teeth and upon subsequent decomposition probably cause decay of the teeth. That the quantity of these particular foodstuffs consumed is an important factor is indicated by the fact that in a series of experiments in which various mixtures of cornmeal and oatmeal were used in compounding the stock ration a gradual increase in the frequency and severity of caries was observed as the amount of cornmeal was increased. Similar observations have been made in the case of other experimental diets in which different amounts of cornmeal were used. The increase in the diet of the so-called "protective" foods is no doubt also accompanied by a change in the physical properties of the food mixture as it exists in the mouth, resulting possibly in a marked decrease in the tendency of food to be retained by the teeth. There is also the possibility that the consumption of certain fruits, fruit juices or vegetables is accompanied by a definite cleansing of the teeth comparable perhaps to the conscientious use of a tooth brush in conjunction with an effective tooth paste.

In view of the results of the experiments described

above, it would appear desirable to give some attention in human dental studies to the physical properties of individual foods and of food mixtures with respect to their tendency for retention by the teeth. The elimination from the diet of foods that are difficult to remove from the teeth would perhaps go far in wiping out dental caries. It is also apparent from the results that a diet considered adequate merely from the chemical point of view is not necessarily a guarantee against dental decay.

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THE EFFECT OF EPINEPHRIN-FREE SUPRARENAL EXTRACT ON THE SPECIFIC DYNAMIC ACTION OF FOODSTUFFS

IN previous publications we[1] described a new calorogenic principle obtained from the suprarenal cortex or whole gland. The active substance is combined in the lipoid fraction and can be extracted from the tissue with methyl or ethyl alcohol. After concentration of the alcoholic extract *in vacuo* at a low temperature, the active protein-free lipoid is obtained by extraction with benzene or ether. The water soluble extract of the lipoid contains epinephrin besides the active substance.[2] Epinephrin, however, is less firmly bound by the lipoid and can first be removed by prolonged washing or mild acid hydrolysis. The calorogenic principle, as we have pointed out, is unstable, but in the absence of oxygen we have found a preparation active after a period of 6 months. In our earlier work the extract was administered orally but the effects were not always constant. Given hypodermically, approximately one tenth to one fifteenth the amount is required, and the results have been much more consistent.

In our clinical work we have noted that in many cases of asthenia, including myasthenia gravis and Addison's disease, the beneficial results obtained diminished upon continued administration of the extract. Daily administration of amounts to dogs sufficient to raise the basal metabolism 40 to 50 per cent. would fail to maintain the increased metabolism after a few days. This "fading" effect upon prolonged administration of the extract has been observed in connection with the increased mechanical efficiency and disappearance of the abnormal creatine excretion in certain asthenias that we have described.

[1] A. E. Koehler, *Proc.* Soc. Exp. Biol. and Med., 26: 296, 1928; A. E. Koehler and L. Eichelberger, *Amer. Jour. Physiol.*, 90: 2, 1929.

[2] A. E. Koehler and L. Eichelberger, *Jour. Biol. Chem.*, 87: XXXVIII, 1930.

In 3 depancreatized dogs and in 3 diabetic patients we have noted that the extract decreases the sugar elimination (40 to 50 gms daily). One severe diabetic patient studied failed to show any such change. After 3 to 4 days the sugar elimination again returned to its former level even upon giving the extract.

In connection with the "fading" action we have noted a diminution or disappearance of the specific dynamic action of foodstuffs. The following results were obtained after various periods of medication. A normal control run was first obtained before treatment was started.

Subjects studied

	Cases
0.5 gm protein gelatine (or egg white) per kilo orally	
S. D. A. completely eliminated	6
S. D. A. materially depressed	3
S. D. A. no change	1
0.3 gm alanine per kilo intravenously	
S. D. A. eliminated	1
S. D. A. materially depressed	2
0.5 gm glucose per kilo intravenously	
S. D. A. eliminated	4
S. D. A. materially depressed	4

Normal dogs

	Cases
20 gms meat per kilo	
S. D. A. completely eliminated	4
2.5 gms alanine per kilo orally	
S. D. A. completely or nearly eliminated	2
2.5 glucose orally	
S. D. A. completely eliminated	10
S. D. A. markedly depressed	9

The rapidity of disappearance of the specific dynamic effect appears to be dependent upon the dosage and upon the duration of the period of medication.

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